

HYBRID COVERLAY/WINDOW STRUCTURE FOR FLEXIBLE DISPLAY APPLICATIONS

RELATED APPLICATIONS

[0001] This application claims the benefit of priority from U.S. Provisional Patent Application Ser. No. 62/735,569 filed on Sep. 24, 2018, the full disclosure of which is incorporated herein by reference.

BACKGROUND

Field

[0002] Embodiments described herein relate to protective cover layer structures for portable electronic devices, and more particularly for flexible displays.

Background Information

[0003] Portable and wearable electronic devices commonly include a housing module that encases various components of the electronic device such as a display screen, touch screen, and protective cover layer. The protective cover layer may be a transparent plastic or glass material that provides a protective outer surface of the electronic device, and also functions as a transparent window for the display screen. Common requirements of the protective cover layer include transparency, rigidity, and scratch resistance.

SUMMARY

[0004] Electronic devices with display panels and protective cover layer structures are described. In accordance with some embodiments, the display panels and protective cover layer structures can be curved, flexible, and/or conformable. In an embodiment, an electronic device includes a display panel and a protective cover layer over the display panel. The protective cover layer may include a transparent support substrate and a hardcoat layer covering an exterior facing surface of the transparent support substrate. The hardcoat layer may optionally define an exterior surface of the electronic device.

[0005] In some embodiments, the hardcoat layer is characterized by a lower elastic modulus and lower hardness than the transparent support substrate. It is not a requirement that the hardcoat layer have a lower hardness. In some embodiments, the hardcoat layer is characterized by a lower elastic modulus and higher elongation-to-break. The hardcoat layer may be formed on a single surface or multiple surfaces of the transparent support substrate. In accordance with embodiments, the transparent support substrate may be a brittle substrate such as glass or sapphire rather than polymeric substrate. Nevertheless, the brittle substrate may be curved, flexible, and/or conformable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a schematic isometric view illustration of a protective cover layer in accordance with an embodiment.

[0007] FIG. 2 is a schematic cross-sectional side view illustration of a bent protective cover layer in accordance with an embodiment.

[0008] FIG. 3 is a plot of simulated tensile strain at the transparent support substrate surface for different hardcoat layer thicknesses in accordance with embodiments.

[0009] FIG. 4A is a schematic top view illustration of crack propagation in a scratched transparent support substrate in accordance with an embodiment.

[0010] FIG. 4B is a schematic top view illustration of crack propagation in a scratched transparent support substrate with hardcoat layer in accordance with an embodiment.

[0011] FIG. 5A is a schematic cross-sectional isometric view illustration of a protective cover layer including an intermediate glass fiber mesh layer in accordance with an embodiment.

[0012] FIG. 5B is a schematic cross-sectional side view illustration of a protective cover layer including an intermediate glass fiber mesh layer in accordance with an embodiment.

[0013] FIG. 6A is a schematic cross-sectional isometric view illustration of a protective cover layer including an intermediate glass fiber mesh layer in accordance with an embodiment.

[0014] FIG. 6B is a close-up schematic cross-sectional side view illustration of the protective cover layer of FIG. 6A including an intermediate glass fiber mesh layer in accordance with an embodiment.

[0015] FIG. 7 is a schematic cross-sectional side view illustration of a protective cover layer including a hardcoat layer surrounding a transparent support substrate in accordance with an embodiment.

[0016] FIG. 8 is a schematic cross-sectional side view illustration of a protective cover layer including a hardcoat layer surrounding a transparent support substrate with tapered edges in accordance with an embodiment.

[0017] FIG. 9 is a schematic cross-sectional view illustration of a protective cover layer including an intermediate polymer adhesion layer in accordance with an embodiment.

[0018] FIG. 10 is a schematic cross-sectional side view illustration of a protective cover layer including an intermediate polymer adhesion layer and hardcoat layer surrounding a transparent support substrate in accordance with an embodiment.

[0019] FIG. 11 is a schematic cross-sectional side view illustration of a protective cover layer including an intermediate polymer layer and hardcoat layer surrounding a transparent support substrate with tapered edges in accordance with an embodiment.

[0020] FIGS. 12A-12B are schematic isometric view illustrations of an electronic device in accordance with embodiments.

[0021] FIG. 13 is a schematic cross-sectional side view illustration of an electronic device in accordance with an embodiment.

DETAILED DESCRIPTION

[0022] Embodiments describe display modules and protective cover layer structures. In particular, embodiments describe protective cover layer structures that may be implemented in curved, flexible, conformable and foldable display modules, and in particular with curved, flexible, conformable and foldable display panels. Various embodiments are described in which a hardcoat layer is applied to a transparent support substrate to form a protective cover layer structure. The hardcoat layer may be characterized as possessing a lower elastic modulus, higher elongation-to-break and optionally a lower hardness than the transparent support substrate. In one aspect, such a hybrid structure may prevent